ICE MACHINES

AND

ANHYDROUS SULPHUROUS ACID,

System—"RAOUL PICTET," Patented.

FOR THE MANUFACTURING OF ARTIFICIAL ICE,

MAKING ICE FLOORS FOR SKATING RINKS, COOLING THE TEMPERATURE OF CELLARS, ETC., OF BREWERS, SOAP AND CANDLE FACTORIES, MAKING ICE FOR STEAMERS, HOTELS, HOSPITALS, ETC., ETC., ETC.

ETIENNE GILLET,
SOLE REPRESENTATIVE FOR AMERICA,
No. 13 BARCLAY STREET,
NEW YORK

1876.

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Prices of Raoul Pictet's Anhydrous Sulphurous Acid Ice Machines.

No.	Pounds of Ice per hour.	Water of Condensation per minute.	Necessary Horse-power	Price of Machine without Power	Price of Machine with Power.
1	55	Pints 21	1		
2	110	42	2		
3	220	84	4		
4	330	126	5		
5	440	168	6		
6	550	210	8		
7	660	252	12		
8	1,100	420	18		
9	2,200	840	40		

Anhydrous Sulphurous Acid : per pound.

RAOUL PICTET'S SYSTEM

OF

ICE MACHINES,

USING

ANHYDROUS SULPHUROUS ACID.

The countries between the 35th degrees of N. and S. latitude have in general too temperate winters to admit of natural ice being obtained in any quantity; and yet these are the countries in which it is most required. The high price at which it is sold prevents many people from buying it. It is for the purpose of rendering the supply of this useful and healthful article abundant and cheap that ice-making machines have been devised. These are of *three classes*, of which we shall give a brief account in order to show the advantages of the new invention, due to a Genevese physicist, M. Raoul Pictet.

The first class comprises

The Machines Using Ammonia.

These are based on the principle, applied by M. Carré, of the solution of ammonia in water. A saturated solution of ammonia is introduced into a boiler which is

heated to 284° to 302° Fahr. The ammonia is volatized under strong pressure, and is liquefied in a condenser washed by a current of ordinary water. The liquid ammonia flows into the refrigerator, where it is evaporated, and it returns into the liquid in a gaseous form. The evaporation is the source of the cold, which may be made very intense.

In order to work an apparatus of this kind, it is indispensable that the first operation be effected, *i. e.*, the liquefaction of the ammonia in the condenser. For this purpose it is necessary that the pressure in the boiler correspond to the tension vapour, at the temperature of condensation, which is 86° Fahr., at least in warm countries. This pressure is raised then to fifteen or eighteen atmospheres, an enormous pressure, and liable to great danger.

Under so great tension the gas penetrates cast-iron plates of $\frac{25}{32}$ inches in thickness, the joints leak, and not being air-tight the ammonia rapidly escapes from the apparatus. The alkaline solution must then be constantly renewed, which is very costly. There is another inconvenience. The fire under the boiler causes deposits, which, increasing day by day, give rise to the danger of an explosion. The fear of such a catastrophe demands constant watchfulness.

In countries less warm, with a water of condensation at 68° Fahr., the tension of the ammonia hardly exceeds eight atmospheres. In these circumstances the Carré machine works well and produces economical results. But in such countries natural ice is abundant, and the service rendered is consequently of less value.

The second class includes—

The Machines Using Ether.

Sulphuric ether was first employed for the manufacture of ice in England.

A large pneumatic pump draws up the vapours of ether, which are formed in a tubular refrigerator, and compresses these vapors in a condenser bathed in well water. The evaporation freezes the water contained in the tanks, while the compression of the vapours and their condensation in the condenser transfer to the well water all the heat freed from the water in the tanks, transformed into ice. A pipe allows the condensed ether to return to the refrigerator, and be again subjected to volatilization.

These machines, more simple than the ammonia ones, are, however, less practicable. Ether is a liquid of small volatility, and gives only weak tensions. At 23° to 27° Fahr. of cold, this tension varies from $3\frac{1}{3}$ inches to $6\frac{1}{4}$ inches of mercury, according to the quality of the ether. The cylinder of the pneumatic machine must then be of considerable dimensions in order to draw up a small weight of ether and produce a limited amount of cold. The whole of the first half of the machine works with an almost complete vacuum, but if the joints, the walls of the tubes, and the caulking of the cylinder are not perfectly hermetic, atmospheric air will enter the apparatus; and should the manometer show that it is present to the extent of ($\frac{3}{8}$ to $\frac{25}{32}$ of an inch) the evaporization of the ether will completely stop. With the smallest amount of air present the machine becomes unworkable;

a hole no larger than a pin-point is sufficient to paralyze the half of its normal product.

Another inconvenience arises from the fact that ether is not a body perfectly constant in its chemical characteristics. Under the action of frequent volatilizations and condensations, it becomes acidified and transformed into less volatile isomeric bodies. On this account it is necessary frequently to change the active liquid, which is very troublesome and expensive.

Lastly, the greases with which the piston of the cylinder is lubricated form a close mixture with the ether, a mixture which is carried into all the apparatus, and which also tends to trammel its regular working.

The third class includes—

Machines Using Compressed Air.

These are the least practicable of all, and have invariably failed on trial. Its principle is as follows: Air is compressed in a large cylinder to nearly three atmospheres. This compression raises the temperature of the air to about 302° Fahr. A current of water cools this air, which enters cold into a second cylinder, where it expands from three atmospheres to the ordinary pressure. This work which it produces upon a second piston is equal to the deduction of the original work, for the two cylinders are coupled, and are worked by the same rod. The air which is expanded lowers the temperature, and gives the second cylinder about 140° Fahr. of cold. This air may be utilized to manufacture ice, or to cool cellars, apartments, &c.

This machine, in order to work well, requires large

cylinders and close-fitting pistons, working air-tight, and with very little friction, a perfectly regulated introduction into the expansion cylinder, and orifices, valves, and flaps without a flaw. But these conditions are almost impossible to realize in practice. A piston of large size, travelling in a cylinder under a temperature of 140° Fahr. of cold, is an abundant source of friction, for it is only imperfectly lubricated by glycerine. A thick coating of frost or ice, produced by the solidification of the vapour of water in the expansion cylinder, is also a cause of accident and trouble in the working. Lastly, the smallest derangement in the aspirating or compressing valves of the first cylinder puts an entire stop to the production of cold. These machines, therefore, are absolutely unequal to the practical solution of the problem.

The foregoing remarks on the three principal systems demonstrate clearly that a perfect machine must realize the following distinctive characteristics for the practical production of artificial ice:

1. Too great pressure must not occur in any part of the apparatus.

2. The volatile liquid employed ought to be so volatile that there will be no danger of air entering; *i. e.*, the pressure must be at least one atmosphere in order to be in equilibrium with the external pressure.

3. It is necessary to have a system of compression which does not require the constant introduction of grease or of foreign materials into the machine.

4. The liquid must be stable, it must not decompose by the frequent changes of condition, and it must not

exert chemical action on the metals of which the apparatus is constructed.

5. Lastly, it is necessary, as far as possible, to remove all danger of explosion and of fire, and for this reason the liquid must not be combustible.

If we examine the whole series of volatile liquids investigated with great care by M. REGNAULT, *only one will be found to satisfy these essential desiderata:* this liquid is *sulphurous anhydride.* $S\ O_2$.

In fact, this body is liquid under the atmospheric pressure at a temperature of 14° Fahr. of cold, and it *does not give pressure higher than four atmospheres* at a temperature of 95° Fahr. of heat. This liquid *does not act on metals or fats ;* it *is not combustible*, and is the *least expensive of all known volatile liquids.* By the process of manufacture discovered by R. PICTET, it *costs less than sulphuric ether.*

Thus, by taking advantage of the general principle of the evaporation of a volatile liquid to produce cold, and utilizing sulphurous acid, we can obtain a machine which gives results *constant in every country*, and which acts in a *perfectly mechanical* and normal manner in all latitudes.

The following is a brief description of a typical machine of R. PICTET'S *system*, manufacturing 550 pounds of ice per hour :

A cylindrical tubular copper boiler has a length of 6 feet $6\frac{3}{4}$ inches, and a diameter of $13\frac{4}{5}$ inches ; 150 tubes of $\frac{13}{32}$ of an inch traverse its entire length, and are soldered at their extremities to each end of the boiler. This first boiler is the refrigerator. It is placed horizontally

in a large sheet-iron vat, which contains 100 boxes of $5\frac{28}{100}$ gallons of water each. An incongealable liquid, (salted water) is constantly circulating in the interior of the refrigerator by means of a screw. This liquid is recooled to about $19\frac{1}{2}^{\circ}$ Farh., in a normal course, and it licks on its return the sides of the tanks which contain the water to be frozen.

In the space reserved between the tubes of the refrigerator, the sulphurous acid liquid is volatilized, and its vapors are drawn up by an aspirating force-pump, which compresses them without the condenser. This condenser is a tubular boiler, the same as the refrigerator; only a current of ordinary water passes constantly through the interior of the tubes, to carry off the heat produced by the change from the gaseous into the liquid state of the sulphurous acid, and by the work of compression. A tube furnished with a gauge tap, adjusted by the hand once for all, permits the liquefied sulphurous acid to return into the refrigerator to be subjected anew to volatilization.

Sulphurous acid has the *exceptionally advantageous property of being an excellent lubricant*, so that the *metallic piston* which works in the cylinder of the compressing pump *requires no greasing*. Thus the introduction of foreign matter into the apparatus becomes entirely impossible.

Eight-horse power at the most is all that is required to manufacture 550 pounds of ice per hour.

A cold of $19\frac{1}{2}^{\circ}$ Fahr. in the bath is amply sufficient to obtain in the boxes a rapid and in every way economical congelation.

With these mechanical arrangements the following important advantages are realized :

1. The pressure never exceeds four atmospheres.

2. There is never any entry of air to fear, since the pressures up to 14° Fahr. are always above that of the atmosphere.

3. The volatile liquid employed is perfectly stable, undecomposable, and without chemical action on metals.

4. All greasing in the machine is dispensed with.

5. The volatile liquid employed is obtained at a very low price, and it is accompanied by no danger of explosion or fire.

6. The cost of production of the ice approaches infinitely near to the theoretic minimum : it is about two dollars ~~and a half~~ per ton of ice.

The force pump can be driven by any power most convenient or available for the purpose—either with steam, horse, or water power.

By means of all these advantages the practical problem of the manufacture of ice may be considered as solved for all climates, and the process of R. Pictet will not fail to be speedily adopted in all warm countries as soon as it becomes known; it is in such countries that its happy results will be especially utilized and appreciated.

The system of Pictet has been adopted by the "Messageries Maritimes" on all the steamers of their line running from Marseilles and Bordeaux, to Algeria, India, Japan, and Egypt.

Large works have been erected in Alexandria for the manufacturing of beer, which has heretofore been impossible on account of the extreme heat.

Also adopted by JOHN GAMGEE of England, who will utilize the same for making the Ice for the Skating Rinks of London and Paris. 32 machines are now under construction for this purpose.

An English Company have also purchased of R. PICTET his system for the introduction of Ice in the East Indies.

Several of these machines have been ordered for keeping at a constant temperature the different rooms of the International Depot of Weights and Measures at Paris, which is the highest possible endorsement of its merits.

Translation.)

Marseilles, April 27, 1876.

Messrs. RAOUL PICTET & Co.,
Geneva.

Dear Sir—I have the pleasure to acknowledge to you, that the working of your ice machines continues in an entirely satisfactory manner. Thus far, as to the abundant and economical production of artificial cold for cellars—I consider them a complete success, and they perfectly and practically demonstrate all your claims for them.

I am exceedingly pleased to have been one of the first to endorse their merits, and beg you to receive my sincere congratulations.

F. FOURNIER,
Soap and Candle Manufactory.

A small specimen of M. PICTET's machine is shown at the Loan Exhibition of Scientific Apparatus at South Kensington, England.

And at the Centennial Exhibition, Phila., U. S., in charge of EMILE BURGIN, who will explain its advantages, show its practical working, also give any desired information. For particulars as to price, terms, &c., address

ETIENNE GILLET,
Sole Representative for America,
13 Barclay Street,
New York.

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